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甘肃灵台雷家河剖面中的日进鼠(Chardinomys)[1)]

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摘要　甘肃灵台雷家河剖面产出的日进鼠化石包括了该属从老到新的所有种类:中新世末—上新世初的 *C. primitivus* sp. nov.、早上新世的 *C. lingtaiensis* sp. nov.、早上新世—晚上新世初的 *C. yusheensis* 和早上新世—晚上新世的 *C. nihowanicus*。系统描述了上述各种,对种间的演化过程及该属与 *Occitanomys* 和 *Orientalomys* 的关系进行了比较和讨论。

关键词　甘肃灵台,晚中新世—上新世,日进鼠,分类和演化

中图法分类号　Q915.873

1　前言

1997～1999 年间郑绍华、张兆群等人在甘肃灵台雷家河剖面通过逐层筛洗,获得了大量小哺乳动物化石标本。通过研究,已列出化石名单,并建立起该地区晚中新世—早更新世(约 7Ma ～1.8Ma B.P.)连续的生物地层序列,但未对各门类作详细描述(张兆群、郑绍华,2000,2001;郑绍华、张兆群,2001)。郑绍华先生将其中 *Chardinomys* 的标本交由笔者作硕士学位论文,以期对该属有更为深入的了解。观察发现雷家河剖面的标本既包括了 *C. yusheensis*、*C. nihowanicus* 等已知种类,也包含了一些不为人知的原始种类。笔者因而对发现于中国的几乎所有日进鼠标本进行了观测,并且由于 *Chardinomys* 和 *Occitanomys* 及 *Orientalomys* 关系密切,对于它们之间的相互关系也进行了探讨。

2　术语及方法

文中所用描述术语依据 Storch(1987)鼠类齿尖模式图,稍作修改。臼齿齿根数系指牙齿四周主要牙根的数目,这样即使在牙床上的牙齿也可以数清齿根数,而不必考虑那些牙根间不稳定的小的根突和须根。测量采用 WILD M7A 显微镜,精确到 0.01mm。化石层位及地层时代顺序据郑绍华、张兆群(2001)。

3　标本记述

鼠科 Muridae Gray, 1821

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日进鼠属 Chardinomys Jacobs et Li, 1982

属型种　*Chardinomys yusheensis* Jacobs et Li, 1982。

归入种　*C. primitivus* sp. nov.; *C. lingtaiensis* sp. nov.; *C. nihowanicus* (Zheng, 1981)。

属征(修订)　小型。M1 的 t1 和 t4 十分后位;t3-t5-t4 前外后内向排列成一直线,(t0)-t2-t3 前内后外向排列成一直线;在原始种类 t6 后方以一沟与 t8-t9 隔开,在进步种类通常以一脊与 t8-t9 联合部相连;缺失 t7;t12 通常发育较弱;前齿带(anterior cingulum,指牙齿冠面前部的隆起)及前附尖(prestyle)较发育。M2 的 t6 后部多以一沟与 t8-t9 相隔,有时与 t9 连;t12 不发育。m1 下前中尖(t_{ma})及唇侧附尖(c1,c2,c3)发育。m1-2 主要齿尖内外成对排列,有时略有交错,中间脊(medial ridge)通常较不发育。

区别特征　区别于鼠科除 *Orientalomys* (Bruijn and Meulen,1975) 外其他各属的主要特征是 t3-t5-t4 连成一线,(t0)-t2-t3 连成一线,两线以近于直角相交。与 *Orientalomys* 的主要区别在于 M1-2 皇冠型不发育,M1 的 t6 与 t9 通常不连接。m1-2 主要齿尖少交错排列,中间脊发育较弱。

原始日进鼠(新种) Chardinomys primitivus sp. nov.

(图 1 a～b)

1987 *Orientalomys* cf. *O. similes*, Storch, p.408, figs. 24, 26, pl. 3; V 8469.2, V 8469.4, V 8469.7

2000 *Occitanomys* n. sp., Zheng and Zhang, p.60, fig. 2; Zhang and Zheng, p.275, figs. 1,3, table 3

2001 *Occitanomys* n. sp., Zhang and Zheng, p.56, fig. 1; Zheng and Zhang, p.216, fig. 3

词源　拉丁词"primitivus",表原始之意。

正型标本　1 左 M1(IVPP V 13327.1 中国科学院古脊椎动物与古人类研究所化石编号,下简记为 V)。

归入材料　8M1 (V 13327.2～9); 5M2 (V 13327.10～14); 1M3 (V 13327.15); 5m1(V 13327.16～20); 1m2(V 13327.21)。

产地及时代　雷家河剖面最下部层位,文王沟 93001 地点 WL20、WL18 层;93002 地点 CL7 层和小石沟 72074(4)地点 L9 层;中新世末—上新世初。

特征　上下臼齿齿尖较圆且多孤立,其间少刺或脊发育。M1 的 t3 与 t2、t6 与 t5 位置十分靠近,t3 与 t5、t4 与 t5 不相连,t6 通常以一沟与 t8-t9 相隔,t9 发育且较 t8 位置靠前,t12 发育;M2 的 t4 有时与 t5 相连,有时不连,t12 弱或不发育。M1-2 具 3 齿根。m1 唇侧附尖 c1、c2、c3 孤立发育,后齿带(cp)多成脊形。m1-2 主要齿尖内外对称排列,中间脊不发育,2 齿根。

描述　M1　冠面大体为卵圆形,舌侧在 t0 位置处凹入。t1 位于 t5 前内侧,远离 t2 和 t3,2/3 的标本有一小刺指向 t5,其余紧靠 t5 而不连;t3 相对 t2 略后位,与 t2 相连;t4 位于 t8 前内侧,较圆或略有前外后内向拉伸;2/3 标本的 t4 与 t8 不连,其余以一脊相连;t5 与 t6 位置靠近而略前;t6 以一深沟与 t8 和 t9 隔开,9 件标本中只有 2 件基部与 t9 连;t6 位置相对 t4 靠前;t8 大而圆;t9 发育,位置比 t8 靠前;t12 发育;8 件可观察标本中,4 件 t0 发育明显,3 件微弱发育,1 件不发育;3 件前附尖发育强,3 件微弱发育,2 件不发育;7 件可观察标本中,3 件前齿带发育,1 件微弱发育,3 件不发育。3 齿根。

M2　冠面近圆形。5 件标本中有 1 件 t1 和 t4 略呈前后向扁长,其余均较圆;t5 磨蚀

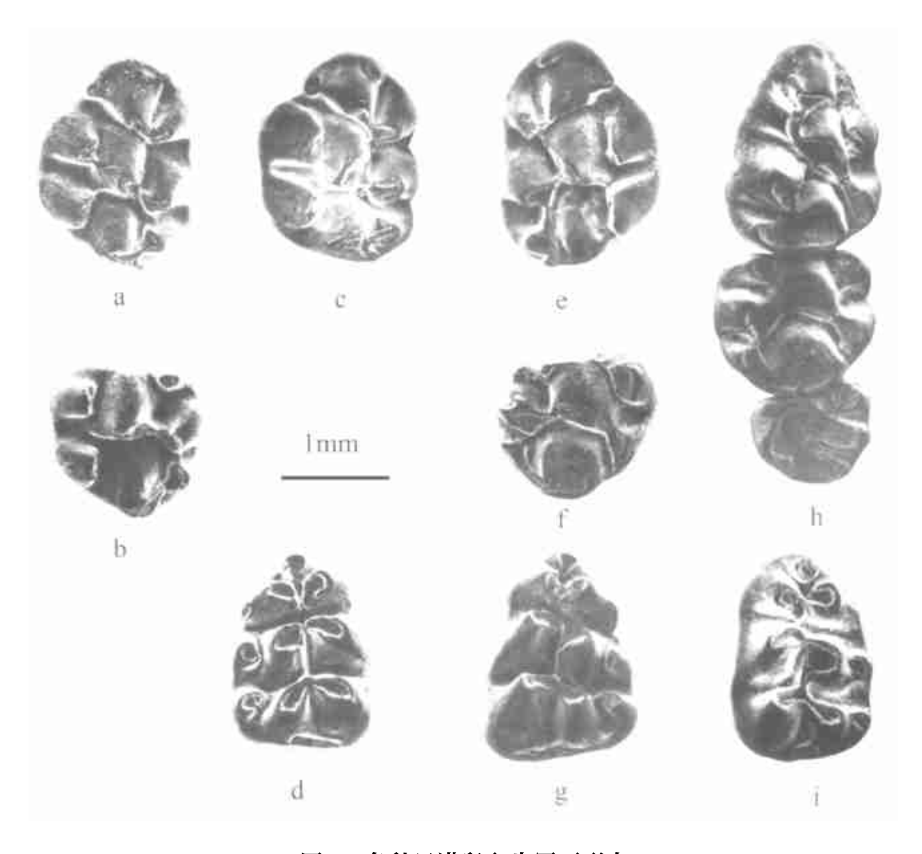


图 1　各种日进鼠臼齿冠面形态

Fig. 1　Molar morphology of different species of *Chardinomys*

C. primitivus sp. nov. a. left M1(V 13327.1);b. left M2 (V 13327.10)

C. lingtaiensis sp. nov. c. left M1(V 13328.1);d. left m1(V 13328.28)

C. yusheensis e. right M1(V 13329.1);f. right M2 (V 13329.65);g. right m1(V 13329.107)

C. nihowanicus h. right M1-3 (V 13330.1);i. right m1(V 13330.86)

面呈锐角三角形;3 件标本 t4 与 t5 相连,其余 2 件不连;t4 与 t8 以一深沟隔开,只有 1 件基部相连;t6 与 t5 位置靠近而略后,比 t4 靠前;5 件标本中有 2 件 t6 与 t9 基部相连,其余以沟与 t8-t9 相隔;t9 位置比 t8 靠前;t12 发育弱或不发育;3 齿根。

M3　t1 显著,横向加宽,以一脊与 t5 相连;t3 不发育;t5 偏向唇侧,t4-t5-t6 连成倒“V”形;t6 后部与 t9 相连;t8、t9 未完全融合,后部有凹陷;2 齿根。

m1　冠面略呈三角形。下前中尖位于两下前边尖之间而孤立;两下前边尖或对称、大小相当,或舌侧下前边尖向外侧倾斜而稍大于较为水平的唇侧者,两尖在磨蚀后相连;中间脊不发育,由下内尖和下次尖组成的第二横脊(下文简称第二横脊)与由下后尖和下原尖组成的第一横脊(下文简称第一横脊)之间以一深沟隔开;第一横脊与下前边尖之间也不相连,只有 1 件下后尖以一小刺与舌侧下前边尖相连;可观察的 4 件标本中 1 件 c3 不发育,其余 c1、c2、c3 均发育;半数 c1 与 c2 大小相当,半数 c1 大于 c2;后齿带发育,前后向压扁,只有 1 件呈椭圆形;唇侧齿带发育;2 齿根。只有 1 件呈椭圆形;唇侧齿带发育;2 齿根。

m2 唇侧下前边尖发育,与下原尖相连;中间脊不发育;2 齿根。其余特征破损不可见。

测量 见表 1。

表 1 雷家河剖面各种日进鼠臼齿测量

Table 1 Measurements of *Chardinomys* **molars from Leijiahe sections** (mm)

牙齿 Tooth	种 Species	标本数 N	长度 Length 平均 Mean	长度 Length 范围 Range	长度 Length 方差 Sd	宽度 Width 平均 Mean	宽度 Width 范围 Range	宽度 Width 方差 Sd	宽/长 W/L
M1	A	9	1.86	1.60～2.00	0.005	1.27	1.20～1.30	0.001	0.68
	B	6	1.89	1.80～2.00	0.003	1.27	1.20～1.35	0.002	0.67
	C	22	1.92	1.75～2.20	0.009	1.28	1.15～1.45	0.005	0.67
	D	31	1.88	1.75～2.10	0.010	1.3	1.10～1.40	0.006	0.69
M2	A	5	1.36	1.30～1.45	0.004	1.34	1.20～1.45	0.013	0.99
	B	3	1.30	1.25～1.35	0.001	1.20	1.10～1.30	0.005	0.92
	C	14	1.28	1.10～1.40	0.006	1.23	1.10～1.35	0.003	0.96
	D	14	1.28	1.05～1.40	0.007	1.20	1.00～1.30	0.012	0.94
M3	A	1	0.90			0.80			0.89
	B	1	0.75			0.90			1.20
	C	6	0.99	0.75～0.85	0.003	0.83	0.75～0.90	0.001	0.83
	D	7	0.91	0.80～0.95	0.003	0.84	0.85～1.00	0.003	0.92
m1	A	3	1.77	1.75～1.80	0.001	1.18	1.15～1.25	0.002	0.67
	B	4	1.82	1.80～1.85	0.001	1.25	1.20～1.30	0.002	0.69
	C	27	1.72	1.60～1.90	0.008	1.14	1.00～1.35	0.009	0.66
	D	38	1.84	1.50～1.90	0.007	1.17	1.05～1.35	0.005	0.64
m2	A	1	1.15			1.1			0.96
	C	27	1.35	1.15～1.50	0.005	1.26	1.05～1.4	0.008	0.93
	D	23	1.29	1.10～1.40	0.004	1.23	1.1～1.35	0.005	0.95
m3	C	8	1.03	0.90～1.20	0.010	0.96	0.85～1.05	0.003	0.93
	D	9	0.98	0.90～1.05	0.005	0.99	0.85～1.15	0.007	1.01

A, B, C, D in column "Species" stands for *C. primitivus* sp. nov., *C. lingtaiensis* sp. nov., *C. yusheensis* and *C. nihowanicus* respectively.

比较和讨论 这批标本已初步显露出日进鼠的基本特征:M1 的 t1、t4 后位,t3、t5、t4 虽不相连,但齿尖中心可连成一线,并与 t2、t3 齿尖中心连线相交,交角接近但不大于 90°,t6 以一深沟与 t8-t9 相隔;m1-2 主要齿尖成对排列,中间脊不发育。

与属型种 *C. yusheensis* 比较,主要不同点在于:1) M1 各齿尖较为孤立,其间少齿脊发育,t3、t6、t9 位置相对更靠前,t6 常以一深沟与 t8-t9 相隔而不是与其联合部相连,t12 较发育;2) 属型种定种时无下臼齿材料,与下面将要描述的雷家河剖面中的榆社种下臼齿对比,原始种 m1 中间脊不发育,附尖发育多,且 c1 相对 c2 稍大;3) 上下臼齿齿根数均少于属型种。

C. primitivus sp. nov. 虽然与 *Occitanomys* (Michaux, 1969) 在 M1 无皇冠型发育,m1 下

前中尖很发育等方面不同,但齿冠形态确实有某些相似,以致被归入该属(张兆群、郑绍华,2000)。其中较为相似的是 *O. sondaari* (Weerd,1976),但区别在于:1)尽管 *O. sondaari* 上臼齿皇冠型相对其他 *Occitanomys* 不发育,但与 *Chardinomys* 相比,其 t3-t5、t6-t9 仍有一定程度的连接,皇冠型已具雏形,而 *C. primitivus* sp. nov. 的 t3-t5 不连,t6-t9 之间连接也很少见,无皇冠型发育;2)尽管二者 M1 冠面在 t0 位置处都有凹入,但 *C. primitivus* sp. nov. 的轮廓更为圆滑,而 *O. sondaari* 的轮廓比较凹凸不平,主要齿尖之间都有凹入;3)二者 M1 的 t1、t4 均后位,但 *O. sondaari* 的 t1 与 t2、t4 与 t5 有时仍以一低的细脊连接,而 *C. primitivus* sp. nov. 的则不相连接。

灵台日进鼠(新种)　Chardinomys lingtaiensis **sp. nov.**

(图 1 c～d)

2000 *Chardinomys* n. sp., Zhang and Zheng, p. 278, figs. 1, 3, table 3

2001 *Chardinomys* n. sp., Zhang and Zheng, p. 58, fig. 1, table 1

2001 *Chardinomys* n. sp., Zheng and Zhang, p. 216, fig. 3

词源　以标本产地灵台的汉语拼音 lingtai 命名。

正型标本　1 左 M1(V 13328.1)。

归入材料　17M1 (V 13328.2～18), 5M2 (V 13328.19～23), 1M3 (V 13328.24), 5m1(V 13328.25～29), 2m2(V 13328.30～31), 1m3(V 13328.32)。

特征　M1 的 t5 前外后内向延伸,略成梭形;t5 与 t3 相连,部分与 t4 相连;t3 相对 t2、t6 相对 t5、t9 相对 t8 位置略后移;t3-t5-t4 中心连线与 (t0)-t2-t3 连线夹角接近直角;下臼齿中间脊不发育,主要齿尖交错仍不显著,但比 *C. primitivus* sp. nov. 稍有增强。

产地及时代　雷家河剖面中下部层位,文王沟 93001 地点 WL14 层,93002 地点 CL5～3 层,小石沟 72074(4)地点 L8～6 层;早上新世。

描述　M1　冠面大体为卵圆形,舌侧在 t0 位置处凹入。半数略强的标本 t3 相对 t2 后位,其余稍后或相当。t4 位于 t8 前内侧,前外后内向拉伸;14 件标本中有 4 件 t4 与 t8 以一脊相连,其余不连。t5 前外后内向延伸,与 t3 连接;15 件标本中有 7 件与 t4 相连,其余不连。t6 靠近 t5,与 t5 连接;12 件标本中有 8 件以一深沟与 t8 和 t9 隔开,3 件基部与 t9 连,1 件与 t8-t9 联合部相连;位置较 t4 靠前。t9 位置与 t8 相当,只有 1 件略靠前。t12 仍有发育。前齿带及前附尖均较为发育。3 齿根。

M2　t1 与 t3 位置相当或略后。t5 横向延伸,舌侧与 t4、唇侧与 t6 相连。t6 位置靠后,半数标本比 t5 后位,比 t4 略靠前;3 件标本均以沟与 t8-t9 相隔。t4 位于 t8 前内侧,5 件标本中 2 件与 t8 不连,其余基部相连。t9 位置较 t8 靠前。4 齿根。

M3　t1 显著,横向加宽,与 t5 相连;无 t3;t5 偏向唇侧,t4、t5、t6 连成倒"V"形;t8 和 t9 融合成一个齿尖,t6 后部与此尖相连。3 齿根。

m1　中间脊不发育,第二横脊与第一横脊之间以一深沟隔开;第一横脊与下前边尖之间连接增多,5 件中有 4 件下后尖以一小刺与舌侧下前边尖相连。5 件标本中 1 件 c3 不发育,其余 c1、c2、c3 均发育;c1 与 c2 大小相当。后齿带发育,3 件标本中 1 件呈三角形,其余 2 件前后压扁成一薄脊。唇侧齿带发育。2 齿根。

m2　唇侧下前边尖发育,与下原尖相连。中间脊不发育,第二横脊与第一横脊之间以一深沟隔开。有 c1 和 c3。后齿带呈稍稍压扁的横向椭圆。2 齿根。

m3 略呈倒三角形。唇侧下前边尖小而孤立。2 齿根。其余特征因破损而不可见。

比较和讨论 *C. lingtaiensis* sp. nov. 与上述 *C. primitivus* sp. nov. 比较,M1 的 t3 相对 t2、t6 相对 t5、t9 相对 t8 位置稍靠后,t4-t5-t3 不仅排成一列,且 t3 与 t5、t4 与 t5 连接更显著;M2 齿根数是 4 而不是 3,t4 和 t6 的位置略微靠后;下臼齿区别不大,仅在附尖的相对大小上稍有区别,前者的 c1 和 c2 大小相当,而后者的 c1 相对 c2 稍大。

Sen (1975) 根据产自土耳其 Çalta 地点的一组孤立的牙齿(包括 2M1,1M2,1m1-3,2m1) 建立了黑海鼠属 *Euxinomys*,属型种为 *E. galaticus*,又于 1977 年将该种所有标本归入 *Orientalomys* 中。据笔者观察,其正型标本(一件 M1,编号 ACA-818) 的 t1 和 t4 很后位,t3-t5-t4 排成前外后内向一线,t0-t2-t3 排成前内后外向一线,t6 与 t8-t9 联合部相连,缺失 t7,t12 发育弱,前齿带发育等,与 *Chardinomys* 特征一致。与 *C. primitivus* sp. nov. 相比,t3 相对 t2、t6 相对 t5 位置更靠后,t3 与 t5 已有连接,显得稍进步;与 *C. yusheensis* 相比,t5 棱形还不很明显,t4 与 t5 不连,且为 3 齿根,又稍原始,因而暂归入 *C. lingtaiensis* sp. nov.。但因标本磨蚀较深,且只此一件,是否真的可以归入日进鼠中,还有待于对具体标本的观察和更多材料的发现。

榆社日进鼠 Chardinomys yusheensis Jacobs et Li, 1982

(图 1 e～g)

1982 *Chardinomys yusheensis*, Jacobs et Li, p. 255, fig. 1

1987 *Orientalomys yusheensis*, Storch, p. 408

1988 *Chardinomys yusheensis*, Zhou, p. 191

1993 *Chardinomys yusheensis*, Cai and Qiu, p. 273

2000 *Chardinomys bilikeensis*, Qiu and Storch, p. 200, figs. 16～21; V 11932, 11933. 1～5

2000 *Chardinomys yusheensis*, Zheng and Zhang, p. 61, fig. 2; Zhang and Zheng, p. 278, fig. 1

2001 *Chardinomys yusheensis*, Zhang and Zheng, p. 58, fig. 1, table 1; Zheng and Zhang, p. 221, fig. 3

材料 47M1 (V 13329. 1～47), 1 M1-2 (V 13329. 48), 23M2 (V 13329. 49～71), 6M3 (V 13329. 72～77), 41m1 (V 13329. 78～118), 36m2 (V 13329. 119～154), 9m3 (V 13329. 155～163)。

产地及时代 雷家河剖面中部层位,文王沟 93001 地点 WL14 层,93002 地点 CL3～1 层,小石沟 72074(4) 地点 L7～2 层;早上新世—晚上新世初。

特征(修订) M1 的 t3-t5-t4 前外后内向连成一线,t0-t2-t3 前内后外向连成一线,二线夹角范围 80°～100°;t6 距离 t5 稍远,以一脊相连;t6 后部与 t8-t9 联合部相连,有时以沟相隔,几乎不与 t9 连接;t9 位置比 t8 靠后且较小;t12 发育弱或不发育;4 齿根;前齿带及前附尖相当发育。M2 的 t6 多以一沟与 t8-t9 相隔,只个别与 t9 相连;4～5 齿根。m1 中间脊稍有发育;c3 发育减弱;2～3 齿根。

描述 上臼齿已由 Jacobs and Li (1982) 详细描述,从略。仅补充描述下臼齿。

m1 下前中尖孤立(41 %),或与舌侧下前边尖相连(28 %),或连于联合部(25 %),还有少量与唇侧下前边尖相连(6 %);两下前边尖对称、大小相当(62 %)或舌侧下前边尖稍向外侧倾斜而略大于唇侧者(38 %),二尖在磨蚀后相连;中间脊稍有发育,约 1/3 的标本第二横脊与第一横脊以一小刺相连,其余不连;第一横脊与下前边尖之间连接增强,有约 1/3 强的标本下后尖与下前边尖相连;c3 发育减弱,约 2/3 的标本上 c3 不发育或发育微弱;其余 c1、c2、c3 均发育;c1 与 c2 大小相当或 c1 < c2,30 件中只有 2 件 c1 > c2;后齿带较

发育,**多为稍经压扁的椭圆**(78 %) ,**少量椭圆或较圆**;**唇侧齿带发育**;2 **齿根**(62.5 %) **或** 3 **齿根**(37.5 %) 。

m2　**唇侧下前边尖发育**,**与下原尖相连**;**中间脊不发育或发育微弱**;**大多数有** c1、c3 **发育**,24 **件标本中有** 5 **件** c3 **发育微弱或不发育**;c1 **一般小于** c3 ,**只有** 10 %**的标本** c1 **和** c3 **大小相当或** c1 **稍大**;**后齿带多呈横向椭圆**,**个别较圆或压扁**;2 **齿根**,3 **件**;3 **齿根**,7 **件**;4 **齿根**,5 **件**;5 **齿根**,3 **件**。

m3　9 **件中有** 4 **件无下前边尖发育**,**其余下前边尖小**、**位置低而孤立**;**下次尖与下内尖融合成一个完整的齿尖**;2 **齿根**,4 **件**;3 **齿根**,2 **件**。

比较和讨论　**与灵台种相比**,**榆社种** M1 **齿尖更趋脊形化**,t3-t5-t4 **在高位相连成脊**, t5 **和** t6 **的距离加大**,t12 **极弱**;m1 **中间脊较发育**;M1 **增加到** 4 **齿根**,m1 **也变成** 2～3 **根**。

C. yusheensis **与产自内蒙古比例克早上新世的** *C.* " *bilikeensis* "(Qiu and Storch ,2000) **比较**,**有如下共同点**:1) t4-t5-t3 **连成前外后内向的一线穿过牙齿**,t2-t3 **连成前内后外向一线**;2) t6 **与** t5 **距离稍远**;3) t6 **与** t8 **相连**;4) 4 **齿根**。**邱铸鼎和** Storch (2000) **认为两者的区别在于比例克标本** M1 **低冠且齿尖强烈后倾**"**呈鱼鳞状**";M1 **的** t1、t4、t5 **伸长**;M1 **前齿带尤为发育**。**经笔者观察原始标本**(**共** 5 **件** M1) ,**其冠高**(**齿尖基部最低点与珐琅质** - **齿质界线之间垂直距离**) **无较大差别**,**都落在** 0.25～0.35mm **范围内**;**磨蚀较轻的标本齿尖后倾**, **磨蚀较深的标本后倾不明显**,**其后倾角度**(**主要齿尖基部与尖端的连线与磨蚀面交角**) **大体介于** 30°**到** 50°**之间**,**与正型标本**(**约** 40°) **无较大差异**;**有** 3 **件标本** t1 **前外后内向伸长**,**其余** 2 **件** t1 **较圆**; *C. yusheensis* **也具特别发育的前齿带**。**因此以上特征不能作为二者之间的区别**,**二者应为同物异名**。

泥河湾日进鼠 Chardinomys nihowanicus **Zheng, 1981**

(图 1 h～i)

1981 *Mus* sp. ,Xue ,p. 35 ,fig. 9 ,pl. II

1981 *Orientalomys nihowanicus* ,Zheng ,p. 349 ,fig. 3

1987 *Orientalomys nihowanicus* ,Storch ,p. 408

1987 *Orientalomys sp. nov.* ,Cai ,p. 125 ,table 1

1988 *Chardinomys louisi* ,Zhou ,p. 181 ,tables 1 ,3 ,4 ,figs. 3a ,b

1991 *Orientalomys nihowanicus* ,Zheng and Cai ,p. 103 ,figs. 2-8 ,2-9 ,tables 4 ,5

1993 *Chardinomys nihowanicus* ,Cai and Qiu ,p. 267 ,figs. 1E ,F ,2 ,3 ,4 ,tables 1 ,2 ,pl. II, 1～12

2000 *Chardinomys nihowanicus* ,Qiu and Storch ,p. 200

2000 *Chardinomys louisi* ,Zheng and Zhang ,p. 61 ,fig. 2

2000 *Chardinomys louisi* , *Chardinomys nihowanicus* ,Zhang and Zheng ,p. 281

2001 *Chardinomys louisi* ,Zhang and Zheng ,p. 60 ,table 1

2001 *Chardinomys louisi* , *Chardinomys nihowanicus* ,Zheng and Zhang ,p. 221 ,fig. 3

特征(**修订**)　M1 **的** t3、t6 **分别远离** t2、t5 ;t5 **和** t6 **之间不相连或在低位连接**; t6 **通常与** t8-t9 **联合部相连**;5 **齿根**。M2 **的** t6 **与** t9 **相连**,4～5 **齿根**。m1-2 **中间脊相对较发育**,**主要齿尖交错排列**。m1 **的** c3 **发育弱或不发育**;c1 **通常小于** c2 ;3 **齿根**。m2 **的** c1 **较** c3 **不发育**;4～5 **齿根**。

材料　1M1-3 (V 13330.1) , 1M1-2 (V 13330.2) , 56M1 (V 13330.3 ～ 58) , 21M2 (V 13330.59～79) , 6 M 3 (V 13330.80 ～ 85) , 5 8 m 1 (V 13330.86 ～ 143) ,

表 2 泥河湾、静乐和灵台的 C. nihowanicus 臼齿特征对比

Table 2 Molar comparisons of C. nihowanicus **from Nihewan, Jingle and Lingtai**

		Daodi Fm., Nihewan	Hefeng, Jingle	Leijiahe, Lingtai
M1	N	159	70	58
	t0 present	70 %	80 %	77 %
	prestyle present	51 %	66 %	62 %
	ac present	45 %	74 %	73 %
	rp of t1 to t3	same level or backward slightly	same level or backward slightly	same level or backward slightly
	rp of t3 to t2	backward	backward	backward
	t1-t5 conn.	75 %	72 %	47 %
	t3-t5 conn.	100 %	100 %	100 %
	t4-t5 conn.	97 %	100 %	100 %
	t5-t6 conn.	37 %	28 %	47 %
	t6-t9 conn.	11 %	9 %	3 %
	rp of t4 to t6	forward slightly or same level	forward slightly or same level	forward slightly or same level
	t4-t8 conn.	29 %	18 %	47 %
	t8-t9 melted	71 %	45 %	84 %
	rp of t9 to t8	backward	backward	backward
	root number	5	5	5 or 6
M2	N	125	54	21
	t1-t5 conn.	63 %	70 %	50 %
	t3-t5 conn.	41 %	63 %	44 %
	rs of t1 to t3	larger or equal	larger or equal	larger slightly
	t1-t3 conn.	5 %	20 %	11 %
	t4-t5 conn.	100 %	100 %	100 %
	t6-t5 conn.	100 %	100 %	100 %
	rp of t6 to t5	backward	backward	backward
	rp of t4 to t6	backward	backward	backward or same
	t6-t9 conn.	48 %	59 %	89 %
	t4-t8 conn.	62 %	54 %	68 %
	root number	5	5	5
m1	N	220	59	60
	mr present	58 %	81 %	91 %
	c3 present	40 %	29 %	48 %
	c1 < c2	52 %	66 %	65 %
	cp	ellipse, round or compressed	ellipse or compressed	ellipse or compressed
	root number	3	3	3
m2	N	131	54	26
	mr present	53 %	59 %	88 %
	c1 present	53 %	61 %	76 %
	c1 < c3	100 %	96 %	100 %
	cp	ellipse or round	ellipse or round	ellipse or round
	root number	4 or 5	4 or 5	4 or 5

ac. anterior cingulum **前齿带**; conn. connection **连接**; mr. medial ridge **中间脊**; N. **标本数**; rp. relative position **相对位置**; rs. relative size **相对大小**。

26m2(V 13330.144～169), 9m3(V 13330.170～178)。

产地及时代 雷家河剖面中上部层位, 文王沟 93001 地点 WL12～10, WL8～7 层, 小

石沟 72074(4)地点L5～1 层;早上新世 —晚上新世。

比较和讨论　与榆社种相比,泥河湾种上下臼齿齿根数目增多;M1 的 t3-t5-t4 在磨蚀早期即已相连,t3、t6 分别远离 t2、t5,且 t6 多不与 t5 相连,t9 位置较 t8 稍靠后;m1-2 主要齿尖更加交错排列,中间脊更为发育。

统计分析(表 2)显示,产自静乐贺丰(周晓元,1988)、泥河湾稻地和红崖南沟(蔡保全、邱铸鼎,1993)等地点的化石和灵台雷家河上述化石特征一致,均应归入 *C. nihowanicus*。

产于陕西渭南游河的 *Mus* sp. (Xue,1981)的材料为一带有 m1-2 的下颊齿列。Jacobs 和李传夔(1982)认为其非常发育的下前中尖与 *Chardinomys* M1 发育的前齿带和前附尖有密切关系。观察文中插图,m1-2 特征确与 *Chardinomys* 一致。根据第一横脊与下前边尖之间有一定连接,唇侧附尖 c1 相对 c2 稍小等特点归入 *C. nihowanicus*。

泥河湾盆地近年不断有日进鼠化石产出。笔者观察了最近产自泥河湾稻地组老窝沟和红崖南沟的 M1 标本共 32 件(倪喜军博士提供),其中只有 3 件标本(老窝沟 2 件,红崖南沟下段 1 件)有 t6 和 t9 相连接的现象,其余标本 t6 和 t8-t9 之联合部相连的特征很稳定。这 3 件标本中只有 1 件 t6 与 t5 在基部以一细脊相连,另 2 件 t6 和 t5 不连。所有标本的观察结果显示同一种内不同个体特征变异范围不大,泥河湾种具有其稳定的特征组合。

4　起源与演化探讨

Chardinomys 各种在雷家河剖面中的地史分布如图 2。其最原始的种类 *C. primitivus* sp. nov. 与 *Occitanomys* 尤其是 *O. sondaari* 的相似性,显示出二者在起源上的联系。其相似表现在以下几点:1)个体大小接近;2)M1-2 皇冠型发育均较微弱,t6 与 t9 的连接都弱或不连;3)M1 的冠面轮廓在 t0 位置均凹入;4)m1-2 中间脊都发育弱或不发育;5)M1-2 均为 3 牙根。*O. sondaari* 是 *Occitanomys* 属中较为原始的种,以后的种类演化趋于个体增大,冠面加宽,M1 的 t1 和 t5 之间距离减小,t1-t2、t4-t5 连接减弱,t6 后位,t6-t9 连接增强,t12 减弱,t0 发育增强,齿缘后部轮廓平滑,牙齿中间一列的齿尖向前等(van de Weerd,1976),这已与 *Chardinomys* 的 M1 上 t3-t5-t4 连接增强,t6-t9 连接减弱的特征有所不同。并且 *O. sondaari* 的生存时代(早 Turolian 期)(Weerd,1976)稍早于 *C. primitivus* sp. nov.,因此 *Chardinomys* 的祖先可能为 *O. sondaari*。

Chardinomys 各种的臼齿特征演化趋势主要可以归纳为以下几点(表 3):

1) 上下臼齿齿根数目增多。M1 齿根数从 *C. primitivus*-*C. lingtaiensis*-*P. yusheensis*-*C. nihewanicus* 依次为 3,3,4,5;其余臼齿也有类似情况。

2) M1 齿尖特征变化主要有两点。一是齿尖脊形化明显,即 t3-t5-t4 的连接逐渐增强。原始种 t3 与 t5、t4 与 t5 几乎不相连接,灵台种 t3-t5 连接多、t4-t5 连接少,榆社种 t3-t5-t4 已相连成脊,泥河湾种的这一脊则更加发育。二是唇侧一列齿尖位置后移。t3 后移,导致 t3-t5-t4 连线与 t2-t3 连线的交角增大;t6 后移,与 t5 相距越来越远,和皇冠型的形态区别越来越大;t9 由原始种的位置较 t8 靠前且很发育,逐渐后移并逐渐退化,最后到泥河湾种的较 t8 后位且与之融合。

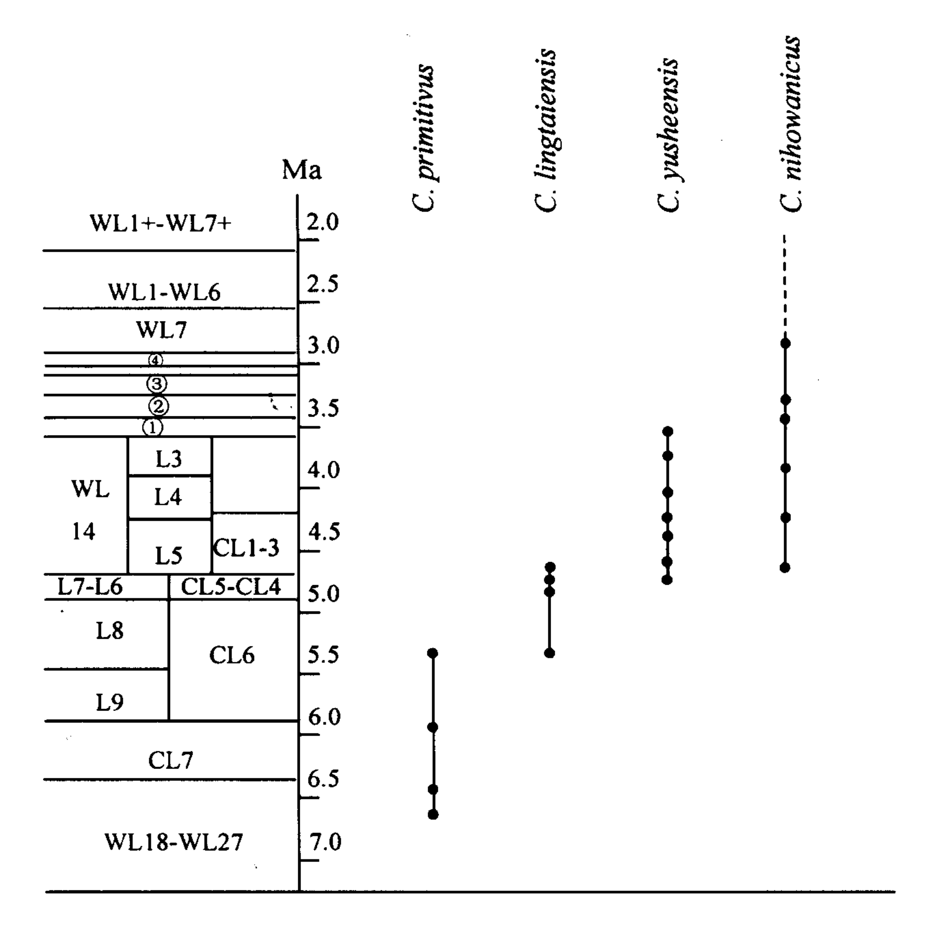


图2 雷家河剖面中 *Chardinomys* 各种的分布

Fig. 2 Distribution of different species of *Chardinomys* in Leijiahe sections

①WL12 and L1-L2; ②WL11; ③WL10; ④WL8

3) m1 主要齿尖交错排列逐渐明显且中间脊发育增强。原始种 m1 主要齿尖基本是左右对称的,灵台种开始稍有交错,舌侧一列齿尖较唇侧位置稍靠前,榆社种的交错较前二者明显,泥河湾种就更明显。中间脊的发育也经历了类似的过程。原始种下前边尖和第一横脊、第一横脊和第二横脊之间均以一深沟相隔,相互之间不连接,灵台种下前边尖和第一横脊之间连接增强,下后尖伸出一小刺指向舌侧下前边尖或与之相连,榆社种除了下前边尖和第一横脊之间连接增强外,第一横脊和第二横脊之间也有连接,而泥河湾种基本上都有连接。

表 3　雷家河剖面 Chardinomys 各种特征对比

Table 3　Molar comparisons of different species of Chardinomys **from Leijiahe sections**

		C. primitivus	*C. lingtaiensis*	*C. yusheensis*	*C. nihowanicus*
M1	N	9	18	48	58
	root number	3	3	4	5
	rp of t3 to t2	backward slightly	backward slightly	backward	backward
	t3-t5 conn.	0	85 %	100 %	100 %
	t4-t5 conn.	0	40 %	94 %	100 %
	rp of t4 to t6	backward	backward	backward slightly or near	near
	t5-t6 conn.	100 %	100 %	82 %	47 %
	rp of t6 to t5	near	near or backward slightly	backward	backward
	rp of t9 to t8	forward	near or forward slightly	near or backward slightly	backward
	t12 present	100 %	100 %	44 %	45 %
	angle of t3-t5-t4-row and t3-t2-row	70 °～ 90 °	80 °～ 85 °	80 °～ 100 °	85 °～ 105 °
M2	N	5	5	24	21
	root number	3	4	4 or 5	4 or 5
	rp of t6 to t5	backward slightly	backward or slightly backward	backward	backward
	rp of t4 to t6	backward	backward slightly	backward slightly or near	near or backward slightly
	t6-t9 conn.	0	20 %	12 %	89 %
	t4-t8 conn.	40 %	40 %	62 %	68 %
	rp of t9 to t8	forward	forward	forward or near	near or forward
m1	N	5	5	41	60
	root number	2	2	2 or 3	3
	mr present	0	0	33 %	91 %
	c3 present	60 %	60 %	33 %	50 %
	rs of c1 to c2	larger or near	near	near or smaller	smaller or near
m2	N	1	2	36	26
	root number	2	2	2～ 5	4 or 5
	mr present	0	0	26 %	72 %
	c3 present	—	50 %	79 %	100 %
	rs of c1 to c3	—	near	smaller	smaller

缩写见表 2(Abbreviations see Table 2) 。

5　与 *Orientalomys* 的关系

由于 *Chardinomys* 与 *Orientalomys* 臼齿冠面特征的相似性,并且由于二者在很多地点如灵台雷家河、内蒙古二登图和比例克、榆社盆地以及泥河湾盆地等共生,二属在分类上往往有一定困难。

二属属型种特征差异比较明显,但原始类型极为接近,主要有以下共同点:1) 齿尖均较圆;2) 齿尖之间距离较近,t3 相对 t2、t6 相对 t5 均不明显后位;3) 除 t2-t3、t5-t6 外,其余齿尖之间少连接;4) 齿根数均较少。

Chardinomys 与 *Orientalomys* 在早期的相似性,显示出二者很可能具相同的起源。从臼齿冠面特征和出现的最早纪录来看,二属似应从共同的祖先中分化出来,以不同的路线和速率演化而成。而二者在后期的相似性,则应与适应相同环境而发生趋同演化有关。

6　结论

1) 雷家河剖面包括了日进鼠已知的从原始到进步的所有类型: *C. primitivus* sp. nov., *C. lingtaiensis* sp. nov., *C. yusheensis* 和 *C. nihowanicus*;

2) 由牙齿构造、种的生存时代及各自属的演化趋势来看, *Chardinomys* 有可能起源于 *Occitanomys sondaari*;

3) *Chardinomys* 和 *Orientalomys* 从相同的祖先演化而来,各自有不同的演化趋势和速率,其间也发生一些特征镶嵌情况;

4) *Chardinomys* 各种在雷家河剖面的地史分布具有重要的生物地层学意义。

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FOSSIL *CHARDINOMYS* (MURIDAE, RODENTIA, MAMMALIA) FROM LEIJIAHE SECTIONS, LINGTAI, GANSU

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Key words　Lingtai, Gansu, Late Miocene-Pliocene, *Chardinomys*, classification and phylogeny

Summary

Totally 394 specimens of *Chardinomys* were collected from 3 sections which ranging from latest Miocene to early Pleistocene near Leijiahe Village, Lingtai County, Gansu Province by screen-washing during 1997～1999 field work seasons. These well stratigraphically calibrated specimens, representing all the forms known in China and 2 new primitive forms of this genus, give an unprecedented chance to revise all the known species and to study systematically the evolutionary relationships of the species in the genus. In addition, the relationships of *Chardinomys* with *Occitanomys* and *Orientalomys* are also discussed in this paper.

1　Systematic paleontology

Muridae Gray, 1821

Chardinomys **Jacobs et Li, 1982**

Chardinomys 与 *Orientalomys* 在早期的相似性,显示出二者很可能具相同的起源。从臼齿冠面特征和出现的最早纪录来看,二属似应从共同的祖先中分化出来,以不同的路线和速率演化而成。而二者在后期的相似性,则应与适应相同环境而发生趋同演化有关。

6　结论

1) 雷家河剖面包括了日进鼠已知的从原始到进步的所有类型: *C. primitivus* sp. nov. , *C. lingtaiensis* sp. nov. , *C. yusheensis* 和 *C. nihowanicus* ;

2) 由牙齿构造、种的生存时代及各自属的演化趋势来看, *Chardinomys* 有可能起源于 *Occitanomys sondaari* ;

3) *Chardinomys* 和 *Orientalomys* 从相同的祖先演化而来,各自有不同的演化趋势和速率,其间也发生一些特征镶嵌情况;

4) *Chardinomys* 各种在雷家河剖面的地史分布具有重要的生物地层学意义。

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FOSSIL *CHARDINOMYS* (MURIDAE, RODENTIA, MAMMALIA) FROM LEIJIAHE SECTIONS, LINGTAI, GANSU

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Key words　Lingtai, Gansu, Late Miocene-Pliocene, *Chardinomys*, classification and phylogeny

Summary

Totally 394 specimens of *Chardinomys* were collected from 3 sections which ranging from latest Miocene to early Pleistocene near Leijiahe Village, Lingtai County, Gansu Province by screen-washing during 1997～1999 field work seasons. These well stratigraphically calibrated specimens, representing all the forms known in China and 2 new primitive forms of this genus, give an unprecedented chance to revise all the known species and to study systematically the evolutionary relationships of the species in the genus. In addition, the relationships of *Chardinomys* with *Occitanomys* and *Orientalomys* are also discussed in this paper.

1　Systematic paleontology

Muridae Gray, 1821

Chardinomys **Jacobs et Li, 1982**

Type species *Chardinomys yusheensis* Jacobs et Li, 1982.

Included species *C. primitivus* sp. nov., *C. lingtaiensis* sp. nov., *C. nihowanicus* (Zheng, 1981).

Diagnosis (revised) Small-sized. On M1, t1 and t4 situated posteriorly; t3-t5-t4 aligned in a diagonal row oriented posterolingually to anterolabially across the tooth, (t0)-t2-t3 located to form a posterolabial-anterolingual diagonal row; t6 separated from t8-t9 by a groove in primitive species or connected with t8-t9 conjunction with a spur or a ridge in progressive species generally; no t7; t12 usually present; anterior cingulum and accessory cusps especially prestyle developed. On M2, t6 separated from t8-t9 or connected with t9 occasionally; t12 lacking. m1 with distinct t_{ma} and labial accessory cusps. Two pairs of main cusps of m1-2 eudipleural or slightly alternating; medial ridge not or weakly developed.

Differential diagnosis *Chardinomys* differs from the other genera of Murinae except *Orientalomys* in having a intersection of t3-t5-t4 row and (t0)-t2-t3 row of nearly right angle on M1. It differs from *Orientalomys* by much less or no stephanodonty, infrequent t6-t9 connection on M1-2, and two pairs of main cusps slightly alternated and weak developed medial ridge on m1-2.

Chardinomys primitivus **sp. nov.**

(Fig. 1 a～b)

Holotype A left M1 (IVPP V 13327.1).

Referred specimens 8M1 (V 13327.2～9), 5M2 (V 13327.10～14), 1M3 (V 13327.15), 5m1 (V 13327.16～20), 1m2 (V 13327.21).

Locality and age Lowest part of Leijiahe sections, Wenwanggou sections Loc. 93001, WL20, WL18; Loc. 93002, CL7; Xiaoshigou section Loc. 72074(4), L9; Late Miocene to early Pliocene.

Diagnosis Molar cusps mostly rounded and isolated. On M1, t3 and t2, t6 and t5 close respectively; t3, t4 and t5 not connected; t6 separated from t8-t9; t9 anterior to t8; t12 distinct. On M2, t4 and t5 connected sometimes; t12 absent or weak. M1-2 both 3-rooted. c1, c2 and c3 on m1 isolated; cp compressed anterior-posteriorly. Two pairs of main cusps on m1-2 eudipleural; no medial ridge; 2-rooted.

Etymology The Latin "primitivus" means "original".

Measurements See Table 1.

Remarks These specimens have posteriorly situated t1 and t4, t3-t5-t4 row intersected t2-t3 row at nearly right angle, isolated t6 on M1; eudipleural main cusps and no medial ridge on m1-2. All these characters agreed well with that of the genus. Comparing with *C. yusheensis*, this new species has: 1) rounded cusps, no connections between t3 and t5 or t4 and t5; t3, t6 and t9 more close to t2, t5 and t8 respectively; t6 separated from t8-t9 and more distinct t12 on M1; 2) no medial ridge; c3 much well developed and c1 larger than c2 on m1; 3) less roots of both upper and lower molars.

C. primitivus sp. nov. can be distinguished from *Occitanomys* by its no stephanodonty on M1 and well developed t_{ma} on m1 but quite similar to *O. sondaari*, which should be the most primitive form of the genus. The differences between the two species are the following: 1) although *O. sondaari* less stephanodonty, it still has t3-t5 and t6-t9 connections, while *C. primitivus* sp. nov. has no t3-t5 connection and very rare t6-t9 connection; 2) the outline of the occlusal surface of *O. sondaari* concaved among the main cusps while only concaved at the anterior-lingual side of t0 in *C. primitivus* sp. nov.; 3) *O. sondaari* has t1-t2 connected and t4-t5 connected sometimes while *C. primitivus* sp. nov. has no such connections.

Chardinomys lingtaiensis **sp. nov.**

(Fig. 1 c～d)

Holotype A left M1 (V 13328.1).

Referred specimens 17M1 (V 13328.2～18), 5M2 (V 13328.19～23),

1M3(V 13328.24), 5m1(V 13328.25～29), 2m2(V 13328.30～31), 1m3(V 13328.32).

Locality and age Lower and middle part of the sections, Loc. 93001, WL14; Loc. 93002, CL5～3; Loc. 72074(4), L8～6; Early Pliocene.

Diagnosis On M1, t5 stretched posterolingually to anterolabially, connected with t3 and sometimes with t4; t3, t6 and t9 slightly posterior to t2, t5 and t8 respectively. Medial ridge not present or weakly developed and the two pairs of main cusps slightly alternated on lower molars.

Etymology Followed the name of Lingtai county.

Remarks Comparing with *C. primitivus* sp. nov., this species has more posteriorly situated t3, t6 and t9 relative to t2, t5 and t8 respectively; well developed t3-t5 and t4-t5 connections on M1; M2 is 4-rooted rather than 3-rooted; c1 and c2 are nearly equal on m1.

The holotype of "*Euxinomys*" *galaticus* (Sen, 1975, 1977), one left M1 (ACA-818), has some characters similar to those of *C. lingtaiensis* sp. nov. They both have t5 connected with t3 and t6 connected with t8-t9 conjunction, t9 reduced and situated nearly at the same level as t8, 3-rooted. But I only watched the cast of this specimen, and it should belong to a rather old individual. To observe the specimen and to find more fossils are still needed to judge wether it belongs to *Chardinomys* or not.

Chardinomys yusheensis **Jacobs et Li, 1982**
(Fig. 1 e～g)

Diagnosis (revised) On M1, t3 and t4 connected with t5; the angle of t3-t5-t4 row and t0-t2-t3 row ranging from 80° to 100°; t6 a little far from t5 and usually connected with it by a ridge; t6 often joined to t8-t9 conjunction; t9 more reduced and posterior to t8; t12 weak; 4-rooted; anterior cingulum and accessory cusps especially prestyle distinct. M2 with t6 separated from t8-t9 or connected with t9 occasionally, 4-5 roots. Medial ridge weak and the two pair of main cusps alternated on m1-2. c3 on m1 weak or lacking; 2-3 roots.

Remarks Comparing with *C. lingtaiensis* sp. nov., *C. yusheensis* has stronger ridges connecting t3-t5 and t4-t5 to form a continuous ridge, larger space between t6 and t5 and more reduced t12 on M1; weak medial ridge on m1 which not present in the former; more roots on both upper and lower molars.

C. "*bilikeensis*" (Qiu and Storch, 2000) may be the synonym of *C. yusheensis* for the following characters they share: 1) t3-t5-t4 row intersect with t3-t2 row almost in right angel on M1; 2) t6 is a little far from t5; 3) t6 connected with t8-t9; 4) 4-rooted; 5) m1 with 2-3 roots.

Chardinomys nihowanicus **Zheng, 1981**
(Fig. 1 h～i)

Diagnosis (revised) M1 with t3 and t6 more posteriorly situated and far from t2 and t5 respectively; t5 separated from t6 by a valley or connected by a ridge; t6 usually joined to t8-t9; 5-rooted. M2 with t6 connected with t9; 4-5 roots. Medial ridge of m1-2 fairly developed and two pairs of main cusps alternated. On m1, c1 smaller than c2, c3 feeble or absent; 3-rooted. c1 of m2 usually absent, c3 present; 4-5 roots.

Remarks *C. nihowanicus* differs from *C. yusheensis* by: 1) M1 with 5 roots rather than 4-rooted; 2) t3, t5 and t4 fused and the ridges among them higher and stronger; 3) more posteriorly situated t3, t6 and more reduced t9; 4) less connected t5 and t6; 5) much well developed medial ridge and more alternated main cusps on m1. Based on the above differences, the materials from Jingle and Lingtai can also be assigned to *C. nihowanicus* (Table 2).

Mus sp. mentioned by Xue in 1981 from Youhe, Weinan, Shaanxi, was considerd "probably closely related to *Chardinomys*" for its "stronger development of a medial anteroconid on m1" "is analogous to the development of the precingulum and prestyle in the M1 of *Chardinomys*" (Jacobs and Li, 1982). Considering the weakly developed medial ridge and smaller c1 comparing to c2, it is preferred to be assigned to *C. nihowanicus*.

2 Discussion on phylogeny

The stratigraphic distribution of *Chardinomys* in Leijiahe sections is shown in Fig. 2.

C. primitivus sp. nov., the most primitive species, has some characters similar to that of *Occitanomys*, espasially to *O. sondaari*. The two species both have weak or no t6-t9 connection; concaved outline of occlusal surface at anterior-lingual side of t0; 3-rooted on M1; weak or no medial ridge on m1-2. There is much possibility that they have consanguineous relationship.

The evolutionary trends among the species of *Chardinomys* from primitive to derived appears to be as the following: 1) the root number of molars increased; 2) on M1, the ridges connecting t3-t5-t4 strengthened; the positions of t3, t6 and t9 moved backward gradually; t12 reduced; the angle of t3-t5-t4-row and t2-t3-row increased from an acute to an obtuse; 3) the medial ridge on m1 strengthened and main cusps alternating more developed (Table 3).

3 The relationship with *Orientalomys*

The relationship between *Chardinomys* and *Orientalomys* is very puzzling because of their similarities and coexistence in the same stratigraphic unit. *Orientalomys* cf. *O. similis* (Storch, 1987) of latest Miocene or eariest Pliocene from Ertemte, Nei Mongol, should be the earlist *Orientalomys* up to now. But 2 M1 (V 8469.2, V 8469.4) out of totally 4 have rounded cusps, no ridge deve-loped, no stephonodenty and t6 separated from t8-t9 conjunction by a deep groove. All these features fit well with what of *C. primitivus* sp. nov.

The *Orientalomys shaubi* from CKT Loc. 18 were firstly thought to be *Stephanomys* (Teilhard de Chardin, 1940) and *Chardinomys* (Zhou, 1988). New materials found recently in the same locality show some similar characters to *Chardinomys* such as posterolingual-anterolabial t3-t5-t4 row and posterolabial-anterolingual t2-t3 row on M1. But its t4 compressed anterior-posteriorly; t6 connected with t5 anterolingually and with t9 posteriorly; t4, t5, t6 and t9 connected by ridges to form a stephanodonty; and more root number etc., are identical with those of *Orientalomys*.

Chardinomys and *Orientalomys* can be distinguished by the following differences: 1) t3, t5 and t4 on M1 is not only aligned in a diagonal row directed posterolingual-anterolabially across the tooth, but also tend to fused to form a ridge in *Chardinomys*, while the ridge not very well deve-loped in *Orientalomys*; 2) t5 is anterolabial-posterolingually elongated in *Chardinomys*, while quite rounded in *Orientalomys*; 3) t3 and t6 are more or less posterior to t2 and t5 respectively in *Chardinomys*, while quite close in *Orientalomys*; 4) t9 reduced, posteriorly situated and fused with t8 in *Chardinomys*, while rather developed and anterior to t8 in *Orientalomys*; 5) t6 separated or connected with t8-t9 conjunction in *Chardinomys*, while only connected with t9 in *Orientalomys*, thus the *Orientalomys* have a stephanodonty; 6) the two pairs of main cusps of m1 are not or weakly alternated in *Chardinomys* while much obvious in *Orientalomys*.

Chardinomys and *Orientalomys* should be derived from a common ancestor considering their similarities in early species.

4 Conclusions

1) The Leijiahe sections yield all the species of *Chardinomys* from the most primitive to advanced: *C. primitivus* sp. nov.- *C. lingtaiensis* sp. nov.- *C. yusheensis*- *C. nihowanicus*;

2) *Chardinomys* might be derived from *Occitanomys sondaari*;

3) *Chardinomys* and *Orientalomys* are closely related and may have a common ancestor;

4) The well calibrated stratigraphic and chronologic distribution of *Chardinomys* has important biostratigraphic significance.

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